The role of plain CT in evaluating cervical disc disease is more controversial. Although thin-section CT (1.5- to 2-mm slices) can demonstrate disc herniations and spondylotic changes, diagnostic accuracy is not as high as in the lumbosacral spine. Many authors advise using an intrathecal water-soluble contrast agent to improve the diagnostic accuracy of CT examination of a patient with cervical degenerative disc disease.

The major limitation of plain CT is its inability to show intradural pathologic processes such as tumors. Conventional myelography or CT with intrathecal water-soluble contrast material is indicated when an intradural abnormality is suspected.

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Radiation Risks in Diagnostic Radiology

THE RISKS OF HARMFUL GENETIC and somatic effects associated with the low doses (a few rads or less) of ionizing radiation received during diagnostic x-ray examinations are too small to be measured. The existence of deleterious effects from much higher doses is irrefutable. The major uncertainty in inferring low-dose risks from dose-effect data obtained at high doses is selecting the type of extrapolation to be used in continuing the dose-effect curve into the low-dose region. Estimates obtained from a no-threshold, straight-line extrapolation of high-dose dose-effect data in animals and, in some instances, humans, to low doses, will be used here. Such estimates are generally considered "worst case," in that alternative plausible extrapolation schemes lead to lower estimates of risk at low doses.

The genetic risk resides in radiation-induced mutations, generally considered deleterious, which can be passed on to future generations via reproduction. No deleterious genetic (or somatic) effect has ever been documented from natural background radiation. This suggests that if the genetically significant dose, estimated in 1970 to be 0.02 rad per capita per year, remains well below the background radiation dose of 0.1 rad per capita per year at sea level, any additional genetic consequences will neither differ in kind nor exceed in quantity those that have been experienced throughout human history. To obtain a numerical estimate is futile, but taking into account that the dose required to double the spontaneous mutation rate is generally assumed to be 20 to 200 rads, the genetic risk of ionizing radiation from diagnostic x-ray studies would appear to be small. Even so, prudence dictates the maximum possible reduction of human gonadal exposure from diagnostic x-ray studies. To this end, gonadal shielding should be used whenever possible during x-ray procedures on a potentially procreative person.

No direct evidence exists for an association between radiation exposure in utero and harm to an unborn child as a result of a diagnostic x-ray study of the lower abdomen or pelvis of a pregnant woman. However, indirect evidence suggests the possibility of radiogenic birth defects and childhood leukemia. The estimated hypothetical risk of an observable birth defect from a 1-rad in utero dose is 1 to 5 chances in 1,000, whereas the natural incidence rate of birth defects is 40 to 50 per 1,000 live births. Studies in animals indicate that the most critical period for inducing a deformity is during organogenesis, weeks 3 through 7 postconception in humans. Human in utero exposure at high doses from the atomic bomb explosions at Hiroshima and Nagasaki indicates weeks 8 through 15 postconception to be the most critical period for inducing mental retardation. Although not seen in these persons, an increased chance of childhood leukemia for an in utero dose of 1 to 2 rads, from a spontaneous incidence rate of 1 per 3,000 to 1 per 2,000, is suggested by some retrospective epidemiologic studies. These possible risks should be explained to a pregnant patient and documented in her record.

The major concern regarding postnatal exposure to diagnostic x-ray studies is carcinogenesis. The estimated hypothetical lifetime risk per study of cancer developing after a latent period of 10 to 25 years varies from a few chances in a million for a (0.05-rad) two-view chest examination to almost 100 chances in a million for a (3-rad) computed tomographic brain scan. These risks are modest compared with the lifetime risk of dying in an auto accident—1 in 100—or contracting cancer spontaneously—180 in 1,000. The most recent screen-film systems for mammography deliver a mean glandular tissue dose as low as 0.1 rad for a two-breast, two-view study, giving an estimated lifetime risk per study for breast cancer induction after a latent period of 10 to 25 years in a woman aged 40 years or older of no more than a few chances in a million, compared with a natural risk of 1 in 10. The hypothetical risk is down dramatically from a decade ago as a result of the great reduction in dose which fact supports routine screening by age 40 as suggested by the American College of Radiology and the American Cancer Society.

In conclusion, the risks from diagnostic x-ray studies are too small to be measured directly. Estimates of the hypothetical risks show them to be small compared with many risks encountered in day-to-day life in American society. Nonetheless, diagnostic x-radiation must be used prudently and every attempt made to obtain the desired diagnostic information with the minimum radiation dose.

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Neonatal Intracranial Ultrasonography

ULTRASONOGRAPHY OF THE NEONATAL BRAIN is a quick, noninvasive procedure that can be done on fragile neonates in an intensive care nursery without sedation. High-frequency sector-image ultrasound is used to examine the brain through open fontanelles and sutures.

Ultrasonography is most important for diagnosing intracranial hemorrhage due to the combination of immaturity of the germinal matrix that lines the ventricles and immaturity of the lungs and the autoregulatory system. This bleeding is the most common central nervous system (CNS) disorder in premature infants younger than 32 weeks' gestation, occurring in 40% to 60% of such children. Ultrasonography can show subependymal, intraventricular or intracerebral germinal matrix hemorrhage in the acute or the convalescent phase.

Serial examinations are helpful for evaluating the progression of hemorrhage, the development and course of posthemorrhagic hydrocephalus and, in some cases, the development of periventricular leukomalacia or porencephaly. Ultrasonography of periventricular leukomalacia is now considered more accurate and reliable than computed tomography (CT).

Ultrasonography can be helpful in diagnosing CNS malformations such as congenital hydrocephalus, holoprosencephaly, agenesis of the corpus callosum, hydranencephaly, Dandy-Walker cysts, intracerebral tumors and arteriovenous malformations. CT, angiography or both may be necessary for further characterization.

Ultrasonography is also useful in evaluating term neonatal asphyxia, intrauterine and postnatal CNS infections, head trauma and hemorrhage due to coagulopathy, but CT is usually more definitive in such cases. Cerebellar and subarachnoid hemorrhage is difficult to image with ultrasonography because the cerebellum, the subarachnoid space and clotted blood are all echogenic.

Because the anterior fontanelle is the primary window used to examine the brain, a small fontanelle or overlapping skull bones will limit the quality of the examination. Also, the convexities of the cerebral spaces are not adequately visualized from the anterior fontanelle and, therefore, CT is preferable for examining these areas. Subcutaneous emphysema will also limit or preclude ultrasonography of the brain.

Ultrasonography has proved useful for diagnosing and following various neonatal brain disorders. And it can be used on infants whose condition is too unstable for them to be examined by other methods.

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Percutaneous Removal of Renal and Ureteral Stones

PERCUTANEOUS REMOVAL of symptomatic renal and ureteral calculi is now a routine radiologic method that has replaced open stone operations in the vast majority of patients. Not only simple renal pelvic stones but also calyceal, ureteral and staghorn calculi can be managed successfully percutaneously.

Assessing a patient's blood coagulating properties and obtaining informed consent are part of the routine preprocedure workup. Pretreating with antibiotics is important in patients with a history or symptoms of urinary tract infection. Carefully evaluating the patient's renal anatomy based on previously taken intravenous urograms is essential for planning the optimal access route. We do dilations up to 24 or larger French sizes as a single-step procedure using epidural anesthesia. With the aid of fluoroscopy or endoscopy, stones are removed using baskets, grasping forceps or by ultrasonic lithotripsy. A nephrostomy tube is left in the renal pelvis for at least 24 to 48 hours. It is removed when residual stone fragments have been excluded and good antegrade flow of urine has been confirmed. Hospital stays range from three to seven days in uncomplicated cases, but may be as long as two to three weeks in patients with staghorn calculi or many calyceal stones. Close cooperation between the radiologist and urologist has proved helpful for optimal patient management.

The success rate for percutaneous removal of kidney stones is 95% and for removal of ureteral stones it is about 90%. Occasional stone fragments left behind are usually small and asymptomatic.

Major complications occur in less than 5% of patients. They include hemorrhage, which is usually well controlled by blood transfusions and balloon tamponade and rarely requires angiographic embolization. A surgical procedure and nephrectomy are extremely rare complications. Urosepsis occurs in less than 1% of patients and responds readily to antibiotic treatment, provided there is good urinary drainage.

The advantages of percutaneous stone removal over surgical nephrolithotomy or ureterolithotomy are lower morbidity, shorter hospital stay, shorter recovery period and reduced cost.

A new technique for renal stone removal is extracorporeal shock wave lithotripsy. This is a noninvasive method that uses focused ultrasound waves to fragment stones. Its overall success rate approaches 90%. Percutaneous nephrostomy with tract dilatation is the method of choice in the other 10% of patients. Furthermore, percutaneous or retrograde manipulations of the genitourinary tract are required in 8% or 9% of patients who are treated with this technique to relieve ureteral obstruction resulting from passing stone fragments.

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Ultrasonography in the Operating Room

RECENT TECHNICAL ADVANCES in instrumentation have led to diverse and innovative applications of ultrasonography including its use in the operating room. High-resolution real-time ultrasound units that are portable with scan heads that are relatively small and easily maneuvered have greatly increased the number of uses of sonography in the operating room. The ultrasound probes are placed directly onto the operative field after the probe is enclosed in sterile coverings. In this way, real-time imaging of the operative site provides a surgeon with immediate information before, during or after the operation.

One of the original and now well-established uses of intraoperative ultrasound is in the neurosurgical suite. There are three main applications of intraoperative ultrasonography in neurosurgery: guiding a shunt tube placement, brain biopsy and spinal cord operations. Sonographic monitoring of shunt tube placement allows correct positioning and alleviates pos-